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INFORMATION CIRCULAR

BLASTING HAZARDS IN STRIP MINES ADJACENT TO UNDERGROUND WORKINGS

BY

J. J. FORBES AND H. F. WEAVER

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BLASTING HAZARDS IN STRIP MINES ADJACENT TO UNDERGROUND WORKINGS[1]

By J. J. Forbes[2] and H. F. Weaver[3]

The rapid increase in the quantity of coal being mined by stripping methods is one reason for the increased interest evinced by safety and other agencies in the hazards that are inherent in this method of mining.

The coal-mining laws of some States contain general provisions governing the mining of coal by open-cut methods, but none contains a complete list of specific safety regulations or laws for the safe operation of such mines. The coal-mining laws of one State empower the head of the coal-mining inspection organization to prescribe regulations for coal-stripping operations and give him the authority and power to enforce the rules and regulations promulgated by him.

Under the Federal Coal Mine Inspection and Investigation Act (Public Law 49, H. R. 2082) of May 7, 1941, the Secretary of the Interior, acting through the United States Bureau of Mines, was authorized and empowered to make or cause to be made annual or necessary inspections and investigations in coal mines for the purpose of obtaining information relating to health and safety conditions in coal mines, such information to be made available to the public. He was authorized and directed to compile, analyze, and publish the information obtained under the act, together with such findings concerning the causes of unhealthy or unsafe conditions, accidents, or occupational diseases in coal mines, and such recommendations for the prevention or amelioration of unhealthy, or unsafe conditions, accidents, or occupational disease in coal mines as he may deem proper.

In complying with the provisions of the act the Bureau of Mines has prepared a set of tentative safety standards for strip mining which is being used as a guide by Federal inspectors when examining a strip mine.

Federal Tentative Standards for Strip Mines state:

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7296."

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Special precautions should be taken when blasting in strip mines that are adjacent to underground workings. Where such conditions obtain, blasting should be done only when all men have been removed from the underground workings. The underground workers should not be allowed to reenter the underground mine after the blasting operations in the strip mine until a thorough search for carbon monoxide and other toxic gases is made in the underground mine and any dangerous gases are completely removed.

The formulation of this standard was prompted by the fact that carbon monoxide resulting from blasting in stripping operations has been drawn into underground workings on several occasions and jeopardized the lives of the workers. Carbon monoxide may result from the detonation of liquid-oxygen explosives or dynamite, as proved by the following accounts of such occurrences within the past few years in this country.

MINE A

Sixty Percent Dynamite Used for Blasting

On October 3, 19__, at 8:50 a.m. 79 holes ranging in depth from 40 to 45 feet were charged with 21,000 pounds of 60 percent gelatin dynamite and fired. At 9:30 a.m. men working on the second level in the underground mine beneath the stripping operation were affected by carbon monoxide, and at 11:45 a.m. men on the first level were affected. One of the men, a veteran mine rescue man, believed that carbon monoxide was present in the air current; through his quick action in rounding up and taking to the surface the 10 men in the mine at the time, serious consequences were avoided.

The air currents in the underground mine were induced by natural means; the intake on the morning of the incident was through openings into the stri mine, and the upcast or return was at the main slope.

The mine officials, realizing that the carbon monoxide came from the stripping operation after the heavy blast, issued the following instructions to prevent a similar occurrence:

> The stripping foreman must report to the mine superintendent (who has charge of the surface and underground mines) before firing heavily loaded holes. Permission to fire must be obtained by the superintendent before such shots can be fired. The blasts must be fired on Sunday or on other days when the underground mine is idle.

MINE B

Liquid-oxygen Explosive Used for Blasting

On October 30, 19__, between 12:30 p.m. and 2:30 p.m., when the workmen in the underground mine were coming off shift, 28 of them were overcome by carbon monoxide. Some were affected seriously, but all recovered after prompt treatment in a nearby hospital.

The underground mine was opened by slopes, and the coal beds are badly folded. Part of the mine workings were underneath a surface stripping operation which had been opened a few months earlier but the officials of the underground mine were unaware of any blasting having been done in the strip mine. A prompt investigation, however, disclosed that on October 30 at 11:00 a.m. 22 holes ranging in depth from 45 to 70 feet were charged with 5,700 pounds of liquid-oxygen explosive and fired at one time.

Ventilation in the underground mine was by natural means. On October 30 the temperature was variable, changing from warm in the morning to below 32° F. shortly after 12:00 noon. The barometric readings fluctuated from high in the morning to low at noon and to high that evening. The fluctuations in temperature and pressure resulted in reversals in the direction of the air currents in the mine. During the evening of October 30 observers noted that the ventilating currents were reversed on three different occasions; this fact indicates very nicely the eccentricities of air currents induced by natural means.

It was learned that some of the holes in the strip mine had been drilled into open chambers or cracks leading directly into the mine workings; many of the holes had to be blocked at the bottom to prevent the explosives from dropping into the underground workings. These holes served as intake openings at the time of the blast, and the gases resulting from the blast were drawn into the active workings of the underground mine.

Carbon monoxide is one of the products of the detonation of liquid-oxygen explosive, and tests of the mine atmosphere at 3:30 p.m. disclosed fairly heavy concentrations of this poisonous gas. It was definitely determined that the carbon monoxide came from the stripping operation.

Tests have shown that large quantities of carbon monoxide may be liberated if liquid-oxygen explosives are detonated after the lapse of a limited period of time following removal from the soaking box. Under such conditions only a portion of the cartridges might detonate; some sections of the cartridges might burn.

After the incident in mine B the company officials issued instructions, in part, as follows:

(a) No blasting shall be done in the open cut until the mine foreman instructs personally the open-cut foreman that there are no men underground.

(b) No men will be permitted underground after a blast on the surface until all of the working places and travelways have been inspected and the air therein tested for carbon monoxide.

MINE C

Proper Procedure

Some mine officials recognize the hazards of blasting in strippings that are adjacent to underground workings and are now taking necessary precautions to eliminate any danger to men working underground. The precautions listed below are being taken by the officials of one company in the anthracite region of Pennsylvania. The procedure followed by this company is sound and is recorded in this circular in the hope that officials of other companies may use it as a guide in solving similar problems.

The detonation of explosives in the strip mine is allowed only when no persons are underground. The day after the blast, before other persons are allowed underground, members of the safety department, equipped with regular gas masks or self-contained oxygen breathing apparatus and hand-operated indicating detectors, enter the mine and make exhaustive tests for carbon monoxide. If carbon monoxide is detected, the tests are continued at intervals until the underground workings are clear, during which time the mine is closed to persons other than trained personnel.

In one case cited by the mine officials 50,000 pounds of explosive was detonated in the strip mine at 10:05 p.m. on July 1 when no one was underground. Members of the safety department entered the mine at 10:00 a.m. the following day and noted that the ventilation in the main slope was static. Carbon monoxide was encountered at the slope heading which is less than 1,000 feet from the slope portal and about 3,000 feet from the area over which the blasting was done. The party proceeded along the main haulage to a point approximately halfway to the active working sections; here they encountered dangerous concentrations of carbon monoxide and withdrew from the mine. The carbon monoxide content of the general air in the mine was 0.05 to 0.09 percent - dangerous quantities if breathed for any considerable period of time.

The mine was idle on July 3, as tests of the mine air proved that carbon monoxide was still present. At 1:00 p.m. on July 4 all travelable openings underground were inspected, and no trace of poisonous gas was detected. The miners were allowed to return to work on July 5.

CONCLUSIONS

Safety engineers, inspectors of mines, or mine officials should realize the possibilities of dangerous concentrations of carbon monoxide produced by the detonation of explosives on the surface being drawn into underground workings. Ordinarily any fumes resulting from blasting on the surface are dispersed forthwith by the wind, but not always under certain conditions.

The necessary precautions taken by the officials at mine C and their experience in connection with blasting in strip mines adjacent to underground workings should be studied carefully by mine officials who are or may be confronted with similar conditions on their properties.

It would be well to follow the procedure outlined below when blasting in strip mines adjacent to underground workings regardless of whether the underground mine is ventilated by natural means, by a blowing system, or by an exhaust system of ventilation.

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(a) Blasting in the strip mine should be done only when no persons are in the underground mine.

(b) Persons, other than those examining the mine, should not be allowed underground until a thorough search for dangerous gases has been made and all dangerous gases removed.

(c) Examination of the underground mine should be delayed until a sufficient time (at least a few hours) has elapsed after blasting in the strip mine.

(d) Persons examining the mine should be suitably protected from the dangers of an atmosphere that is likely to contain concentrations of toxic gases.